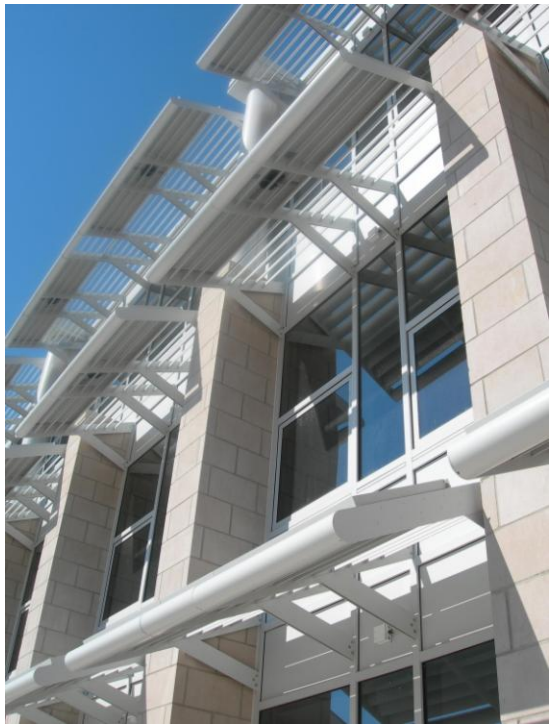
Greening America's Schools: Costs and Benefits



Author: Greg Kats

Capital E Report, 2006

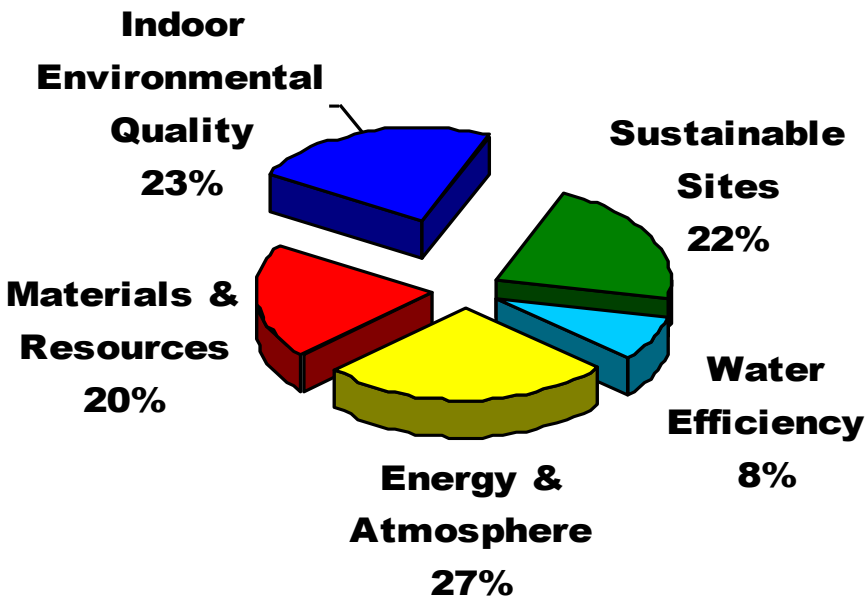
Sponsoring Organizations:

- American Federation of Teachers
- American Institute of Architects
- American Lung Association
- Federation of American Scientists
- US Green Building Council

"This carefully documented study conclusively demonstrates the financial, environmental, and other benefits of using green technologies in schools. In fact, failure to invest in green technologies is not financially responsible for school systems; the study uses conservative accounting practices to show that investments in green technologies significantly reduce the life-cycle cost of operating school buildings. And the public benefits of green schools are even larger than those that work directly to the financial advantage of schools. These include reductions in water pollution, improved environmental quality, and increased productivity of learning in an improved school environment."

- Henry Kelly, President, Federation of American Scientists

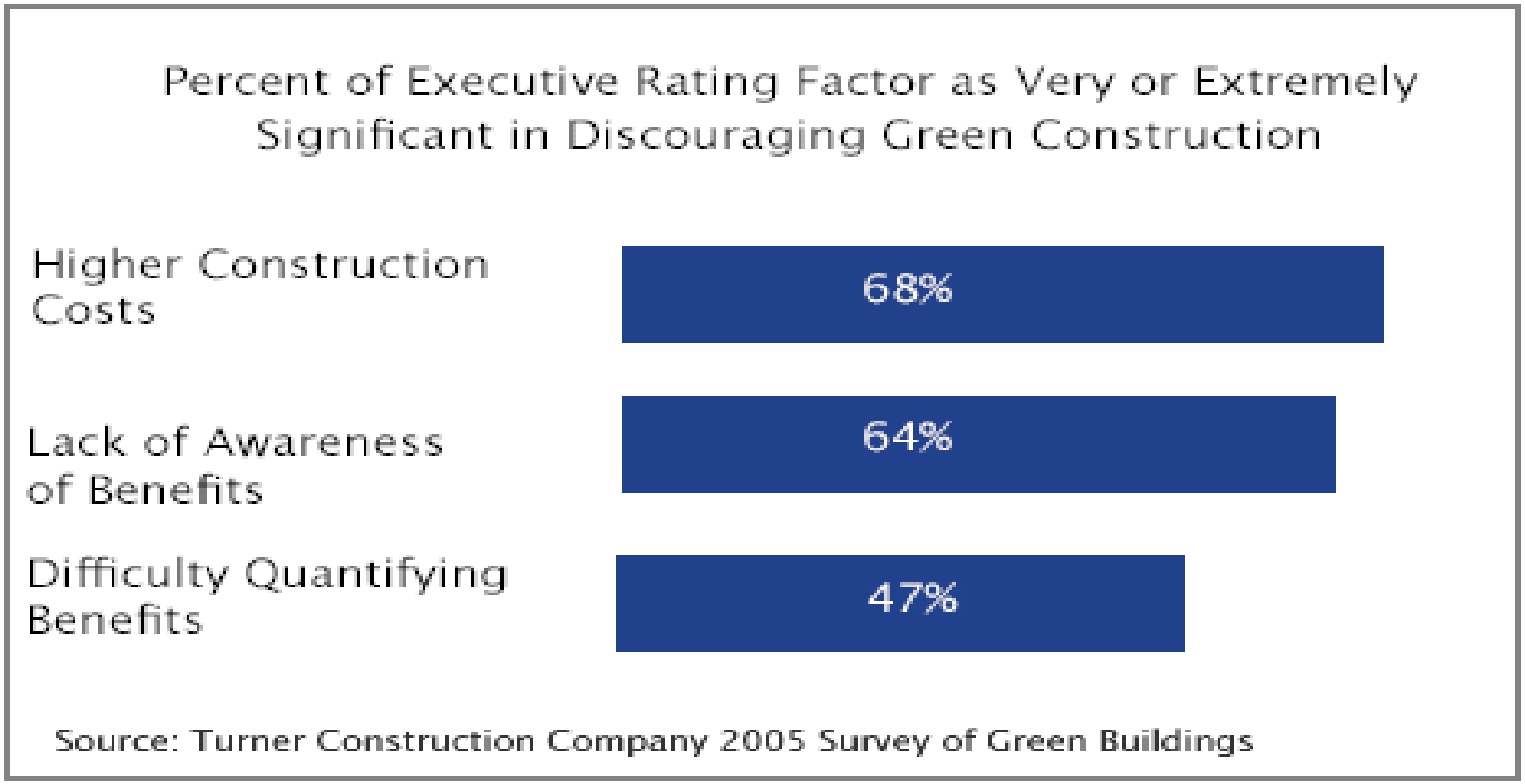
Green Building Elements



Importance of School Design

- 55 million students are in school everyday
- Schools typically designed just to meet codes
- Studies show that many schools are unhealthy – poor ventilation, poor lighting
- School conditions impact both student health and ability to learn
- School budgets are often constrained – struggle to maintain facilities and improve educational standards
- $35 billion projected to be spent on school construction in 2007

Figure A: Factors Discouraging the Construction of Green Buildings



From: "2005 Survey of Green Building," Turner construction/

Greening America's Schools, Capital E, 2006. Survey of 665 senior executives.

Available at: http://www.turnerconstruction.com/greensurvey05.pdf

Study objective

How much more do green schools cost?

Is greening schools cost effective?

Methodology

To evaluate the costs and benefits of green schools, we calculated net present value (NPV) which represents the present value of an investment's discounted future financial benefits minus any initial investment.

Assumptions

- Typical School
  - Term: 20 years NC, 15 years retrofit
  - Inflation: 2%
  - Discount rate: 5% real
  - 2006 base year
- Energy Prices:
  - Electricity: $0.09 kWh
  - Natural gas: $11.50/ thousand CF
  - Annual Increase: 5% per year
- **Green Building Standards:**
  - LEED
  - MA CHPS (Collaborative for High Performance Schools)
  - WSS (Washington Sustainable School (WSS) Protocol for High Performance Facilities)

Green Schools used in analysis

Name	State	Year Completed	2005 MA-CHPS	LEED Score	LEED Level (or LEED equivalent)	Cost Premium	Energy Savings	Water Savings
Ash Creek Intermediate School	OR	2002				0.00%	30%	20%
Ashland High School*	MA	2005	19			1.91%	29%	
Berkshire Hills*	MA	2004	27			3.99%	34%	0%
Blackstone Valley Tech*	MA	2005	27			0.91%	32%	12%
Capuano	MA	2003		26	CERTIFIED	3.60%	41%	
Canby Middle School	OR	2006		40	GOLD	0.00%	47%	30%
Clackamas	OR	2002		33	SILVER	0.30%	38%	20%
Clearview Elementary	PA	2002	49	42	GOLD	1.30%	59%	39%
Crocker Farm School	MA	2001	37			1.07%	32%	62%
C-TEC	OH	2006	35	38	SILVER	0.53%	23%	45%
The Dalles Middle School	OR	2002			SILVER	0.50%	50%	20%
Danvers*	MA	2005	25			3.79%	23%	7%
Dedham*	MA	2006	32			2.89%	29%	78%
Lincoln Heights Elementary School	WA	2006			SILVER		30%	20%
Newton South High School	MA	2006		32	CERTIFIED	1.36%	20%	20%
Melrose Middle School	MA	2007	36			2.02%	29%	35%
Model Green School	IL	2004		34	SILVER	0.99%	30%	20%
Prairie Crossing Charter School	IL	2004		34	SILVER	3.00%	48%	16%
Punahou School	HI	2004		43	GOLD	6.27%	43%	50%

Green Schools (cont.)

Name	State	Year Completed	2005 MA-CHPS	LEED Score	LEED Level (or LEED equivalent)	Cost Premium	Energy Savings	Water Savings
Third Creek Elementary	NC	2002		39	GOLD	1.52%	26%	63%
Twin Valley Elementary	PA	2004	41	35	SILVER	1.50%	49%	42%
Summerfield Elementary School	NJ	2006	42	44	GOLD	0.78%	32%	35%
Washington Middle School	WA	2006		40	GOLD	3.03%	25%	40%
Whitman-Hanson*	MA	2005	35			1.50%	35%	38%
Williamstown Elementary School	MA	2002	37			0.00%	31%	
Willow School Phase 1	NJ	2003		39	GOLD		25%	34%
Woburn High School*	MA	2006	32			3.07%	30%	50%
Woodword Academy Classroom	GA	2002		34	SILVER	0.00%	31%	23%
Woodword Academy Dining	GA	2003		27	CERTIFIED	0.10%	23%	25%
Wrightsville Elementary School	PA	2003		38	SILVER	0.40%	30%	23%
AVERAGE						1.65%	33.4%	32.1%

Energy and water benefits

- Direct Energy Cost Savings (~33%)
- Indirect Energy Savings (price impact)
  - Equal to 50% of Direct Energy Cost Savings
- Emissions Reduction NOx, SO_2, CO_2, PM_{10}, Hg
- Water/Wastewater Efficiency
  - Indoor Low-flow Plumbing, Landscaping, Rainwater Catchment
  - Reduced water/sewer expenditures (~32%)
  - Avoided societal costs of increasing capacity and of water and wastewater treatment

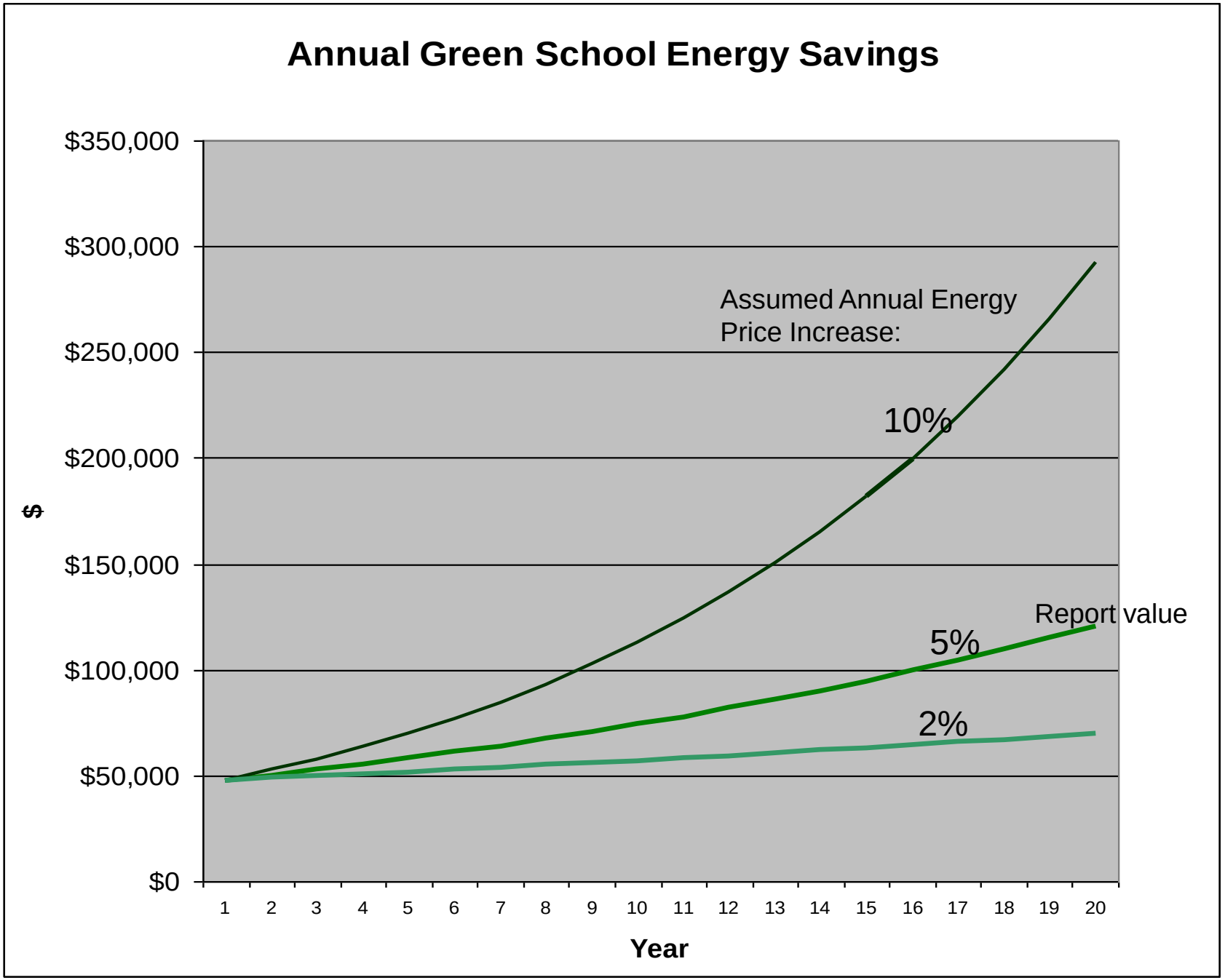
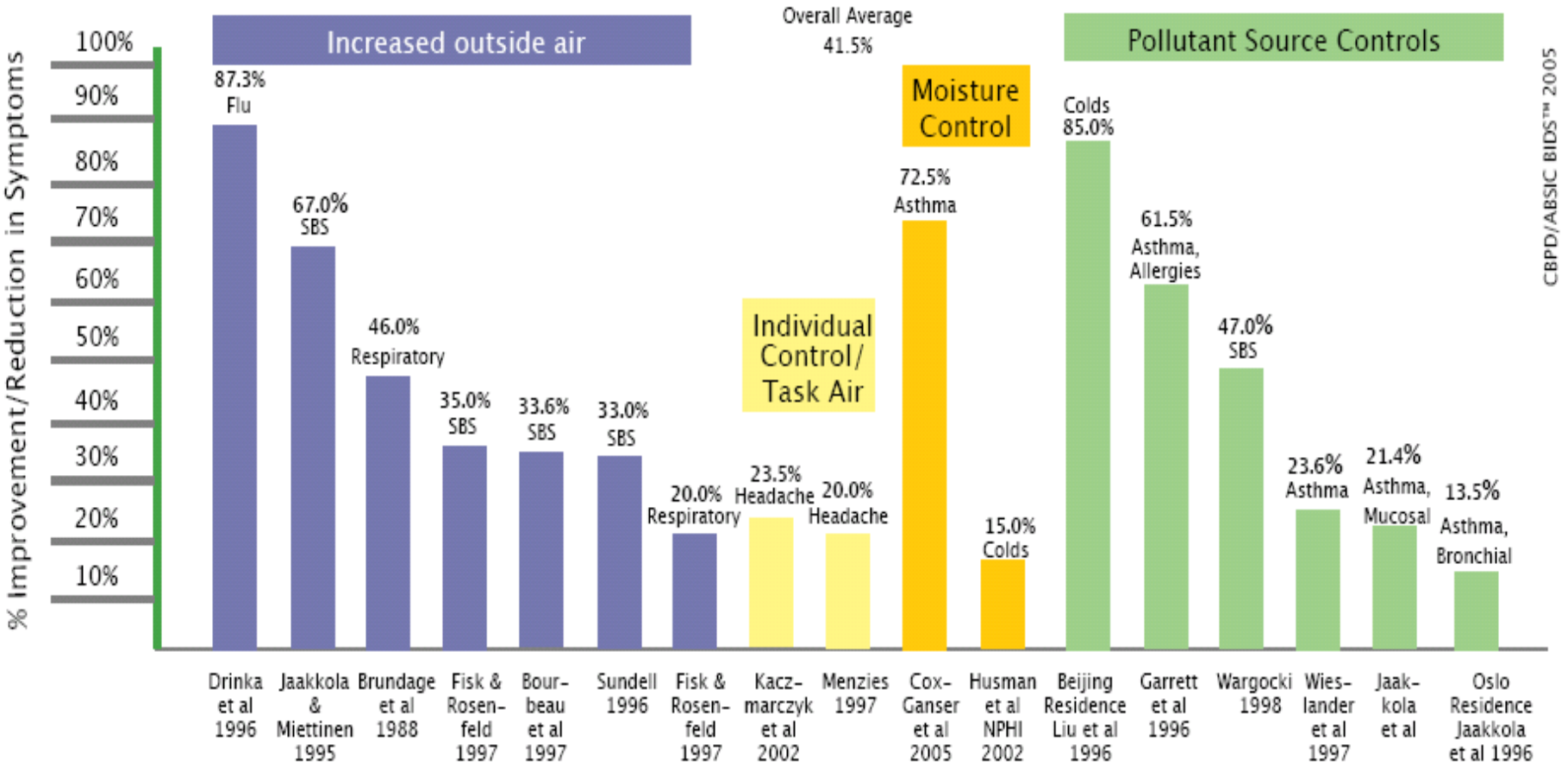
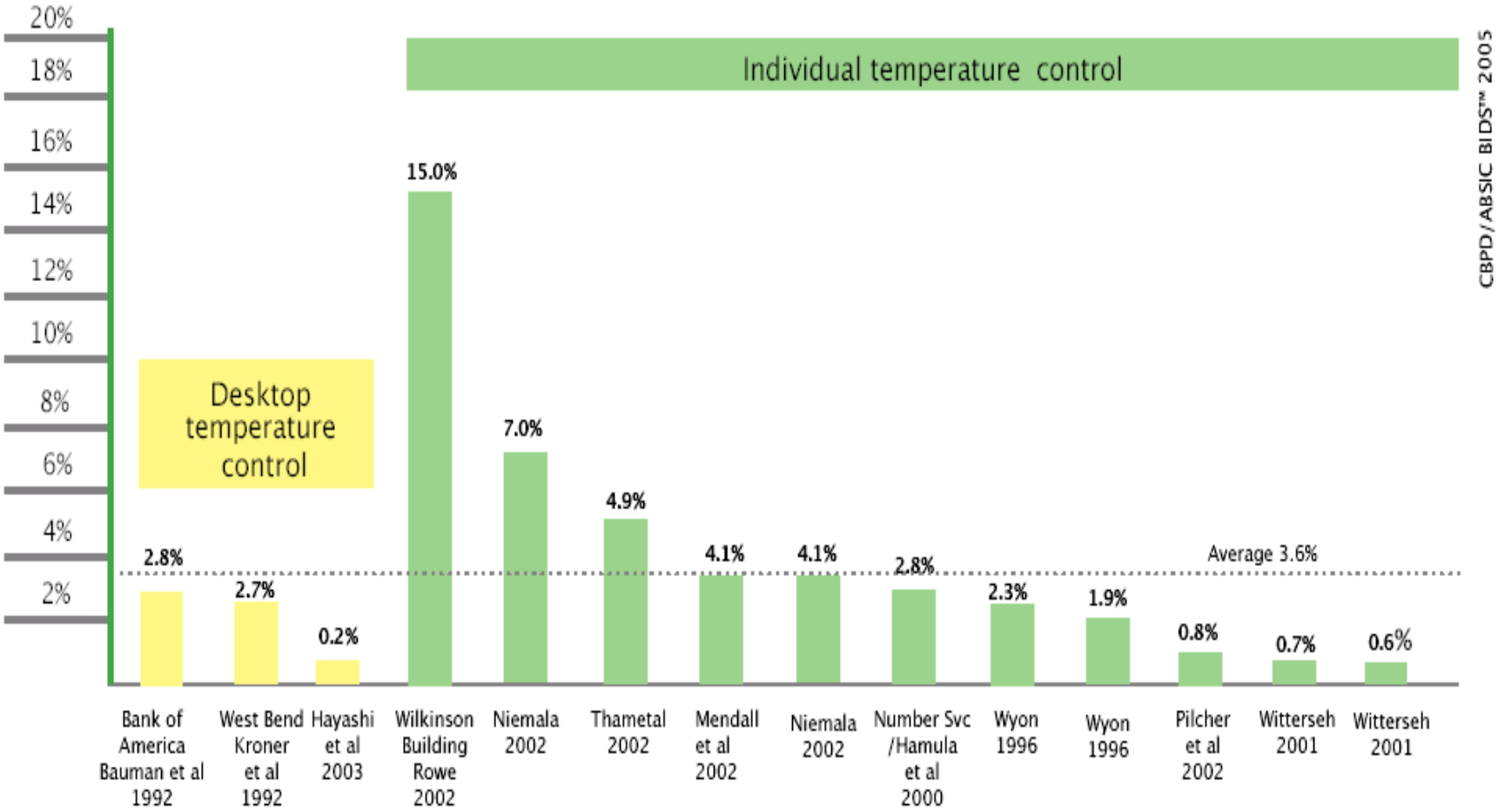

Annual Green School Energy Savings
$350,000
$300,000
$250,000
$200,000
$150,000
$100,000
$50,000
$0
$
Assumed Annual Energy Price Increase:
10%
5%
2%
Report value
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Year

Figure B: Health Gains from Improved Indoor Air Quality



Source: Carnegie Mellon University Center for Building Performance, 2005/ *Greening America's Schools,* Capital E, 2006

Figure C: Productivity Gains From Improved Temperature Controls



Source: Carnegie Mellon University Center for Building Performance, 2005

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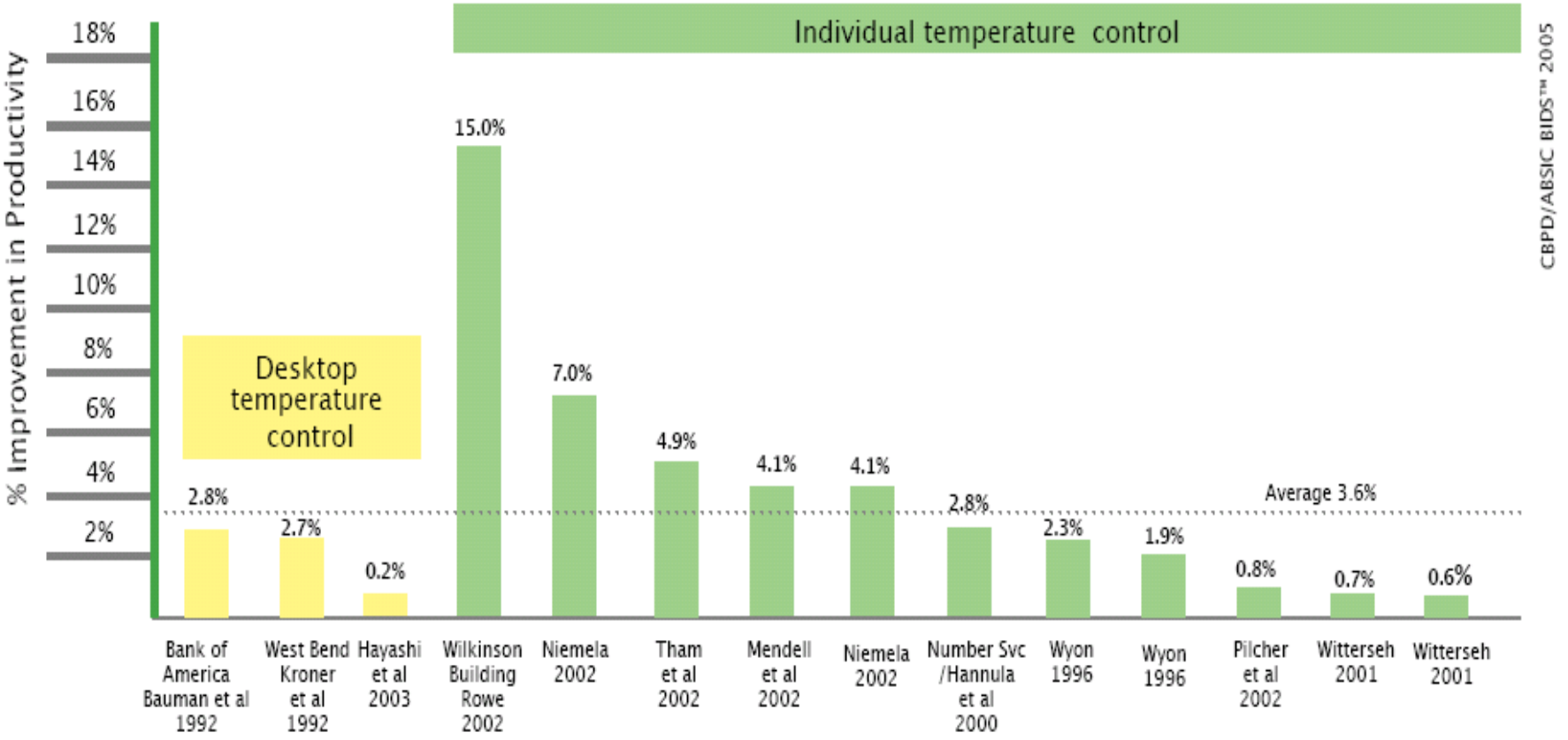


Source: Carnegie Mellon University Center for Building Performance, 2005/ *Greening America's Schools,* Capital E, 2006

Health & Learning
Benefits of Green Schools

Increased Learning, Productivity & Performance (3%)

Increased Future Earnings of Students (1.4%)

Reduced Asthma (25%)

Reduced Colds and Flu (15%)

Reduced Teacher Turnover (3%)

Employment Benefits of Green Schools

- Energy Efficiency
  - 3 short term jobs, ½ of a long term job per school
- Renewable Energy
  - More labor intensive, less polluting (not quantified)
- Waste Diversion
  - Recycling creates nearly 2x more jobs than waste disposal (not quantified)

Financial Benefits of Green Schools

Benefits to school

- Energy savings
- Water savings
- Teacher retention
- In-school health care cost savings

Benefits to broader community

- Emissions reductions
- Increased earnings
- Employment impact
- Health care cost savings

The Financial Benefits of Green School Design ($/ft^2)

Table A: Financial Benefits of Green Schools ($/ft^2)	
Energy	$9
Emissions	$1
Water and Wastewater	$1
Increased Earnings	$49
Asthma Reduction	$3
Cold and Flu Reduction	$5
Teacher Retention	$4
Employment Impact	$2
TOTAL	$74
COST OF GREENING	($3)
NET FINANCIAL BENEFITS	$71

Source: *Greening America's Schools,* Capital E, 2006

Additional Benefits not Quantified

- Reduced Teacher Sick Days (probably ~$2/ft^2)
- Insurance and risk related benefits
- Lower Operations and Maintenance (O&M) Costs
- Enhancement of generating system reliability and improved power quality
- Stormwater reduction and reduced infrastructure costs
- Improving equity and addressing spiritual values
- Educational enrichment as an aspect of greener, healthier facilities
- Slowing global warming

Insurance Impact of Green Design

		Energy & Atmosphere	Professional Liability	General Liability	Business Interruption	Property Liability	Health Insurance	Life Insurance
	Prereq 1	**Fundamental Building Systems Commissioning** (Required)	+	+	+		+	
	Prereq 2	**Minimum Energy Performance** (Required)	+/-	+	+		+/-	+
	Prereq 3	**CFC Reduction in HVAC&R Equipment** (Required)						
	Credit 1.1	**Optimize Energy Performance**, 20% New / 10% Existing (2 points)	+/-	+	+		+/-	+
	Credit 1.2	**Optimize Energy Performance**, 30% New / 20% Existing (2 points)	+/-	+	+		+/-	+
	Credit 1.3	**Optimize Energy Performance**, 40% New / 30% Existing (2 points)	+/-	+	+		+/-	+
	Credit 1.4	**Optimize Energy Performance**, 50% New / 40% Existing (2 points)	+/-	+	+		+/-	+
	Credit 1.5	**Optimize Energy Performance**, 60% New / 50% Existing (2 points)	+/-	+	+		+/-	+
	Credit 2.1	**Renewable Energy**, 5% (1 point)	-		+			

Clearview Elementary School

High-performance features enhance learning environment

Materials

Clearview Elementary School's innovative building materials require less energy to produce and use, create less pollution, and deplete fewer resources than their conventional counterparts. For example, about 70% of the building materials were **locally manufactured**. There are significant energy savings when materials, such as the building's bunklock siding, don't have to be hauled long distances. About 15% of the building materials are manufactured with a high-recycled content. More than 5% of the building materials, such as the wheat board millwork and wainscoting, are made from rapidly **renewable resources**. Wheat board is manufactured from wheat stalks and chaff, an agricultural waste, and is as durable as particle-board. During construction, more than 50% of construction wastes were diverted for reuse or recycling. The school also has a central space for materials separation and recycling.

Lighting

Energy-efficient electric lighting complements the school's natural lighting. Light-level sensors dim the electric lights on bright, sunny days and turn them up on cloudy days or at dusk. High-efficiency fluorescent lights and compact fluorescent fixtures save energy, as do occupancy sensors that turn off the lights when no one is around. Many lights throughout the school are also manually dimmable.

Daylighting

The design ensures that daylight reaches all educational spaces in the school. The classroom wing is oriented along an east-west axis to maximize the amount of light streaming in north- and south-facing windows. The wing is long and narrow to help light penetrate into the center of the building. High, south-facing **clerestory windows** (located behind and above the corridor) bring abundant natural light into second-floor classrooms. There, white reflective exposed roof decking and classroom walls evenly distribute the sunlight. A large, north-facing window wall brings daylight into first-floor classrooms. Highly insulated skylights funnel natural light into the music room.

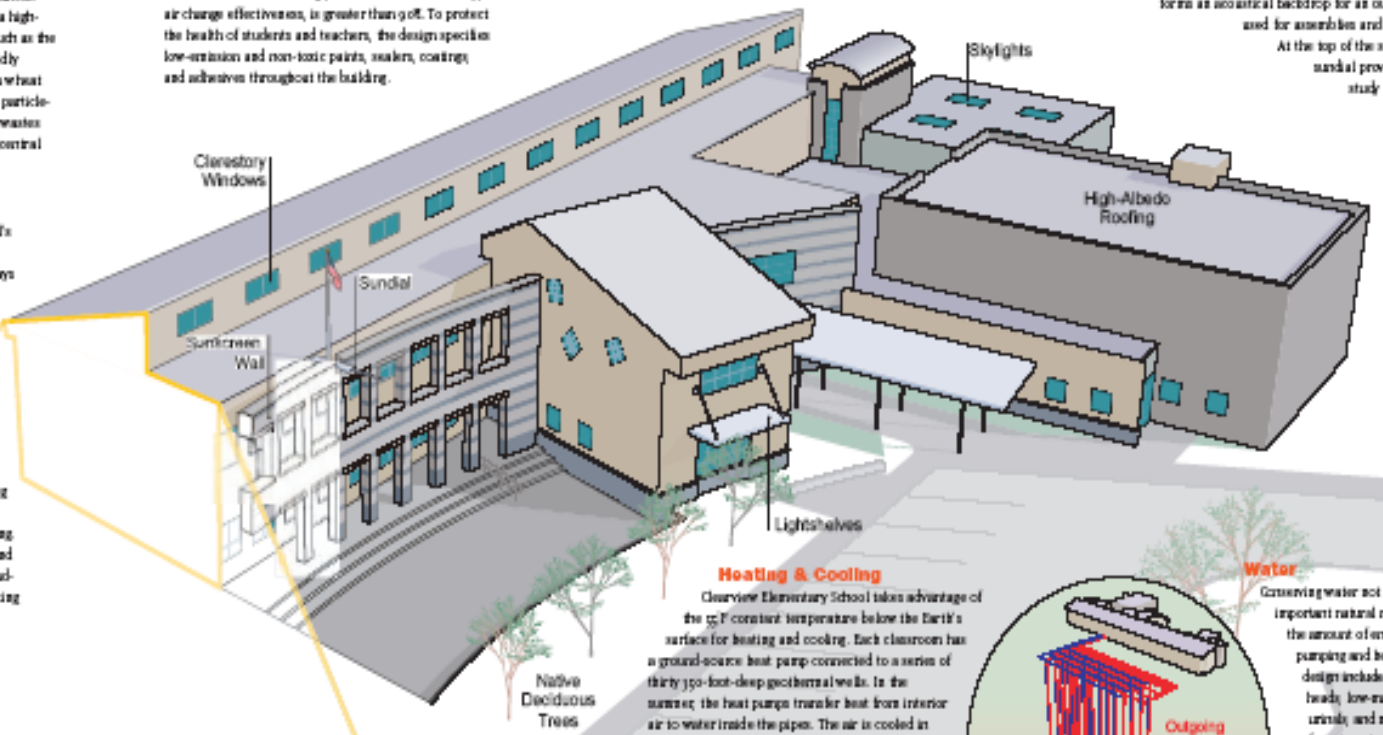
Indoor Air Quality

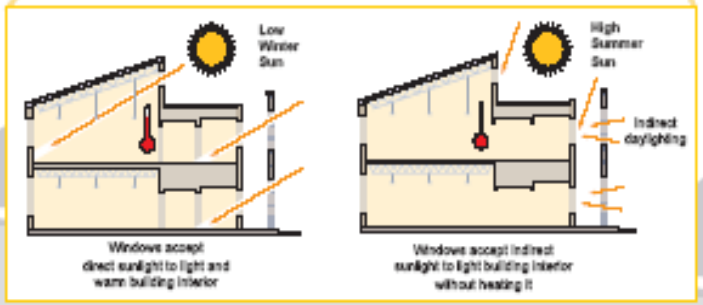
The design emphasizes superior indoor air quality. Floor-mounted air diffusers deliver fresh air to each classroom in response to changes in temperature, humidity, and carbon dioxide levels. Because fresh air comes up from the floor (close to where people breathe) rather than high above them as in conventional buildings, the ventilation efficiency, or air change effectiveness, is greater than 50%. To protect the health of students and teachers, the design specifies low-emission and non-toxic paints, sealers, coatings, and adhesives throughout the building.

Building Envelope

Insulation throughout the building envelope helps keep the building warm in winter and cool in summer. The building's insulating windows are triple-pane, filled with argon gas, and have a low-e coating to reduce heat loss while allowing light to enter. Insulated concrete form (ICF) exterior walls provide high levels of insulation as well. A curved sunscreen wall in front of the building's two-story glass corridor wall provides shading from the hot summer sun and helps support a horizontal sunshade for second-floor windows. The sunscreen wall also forms an acoustical backdrop for an outdoor amphitheater used for assemblies and presentations.

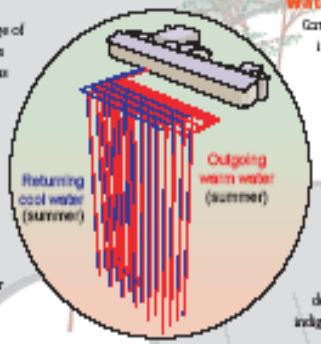
At the top of the sunscreen, a working sundial provides focus for the study of the sun.





Heating & Cooling

Clearview Elementary School takes advantage of the 55°F constant temperature below the Earth's surface for heating and cooling. Each classroom has a ground-source heat pump connected to a series of thirty 350-foot-deep geothermal wells. In the summer, the heat pumps transfer heat from interior air to water inside the pipes. The air is cooled in the ground to 55°F before being returned to the school. In winter, the heat pumps withdraw heat from the 55°F water in the ground to help heat air to 90°F. The cold water is then sent back into the Earth for rewarming. Ventilating units make classrooms more comfortable by dehumidifying the air in summer and adding moisture in winter. Floor-mounted air diffusers send conditioned air from the heat pumps into the classrooms.



Water

Conserving water not only protects an important natural resource, it also reduces the amount of energy needed for water pumping and heating. The building design included low-flow shower-heads, low-maintenance waterless urinals, and mechanical push button faucet controls to reduce water consumption for hand washing by more than 30% relative to conventional construction. The faucet controls alone reduce water consumption by more than 40%. The landscaping design also saves water by using indigenous plants that don't require irrigation.

The building's **passive solar** design enhances winter heating and summer cooling. Clerestory windows, horizontal sunshades, reverse-baffle solar shading devices, and a sunscreen wall keep hot, direct sunlight out of the building in the summer. These features allow only cooler, indirect natural light into the building when the sun is high in the sky. During the winter when the sun is low in the sky, clerestories allow direct sunlight inside to light and warm the building. The main corridor's north masonry wall and terrazzo floor help retain solar heat.

New Haven Public Schools

- Adopted a combination of LEED and energy star guidelines for some of their school construction and renovation plans
- 8 new schools constructed that are expected to consume 30% less energy
- Lower utility cost by $400,000 per year which will yield over a $10,000,000 lifetime savings over the next 20 years.

Greening Affordable Housing

7,000 units in 25 states in first 24 months

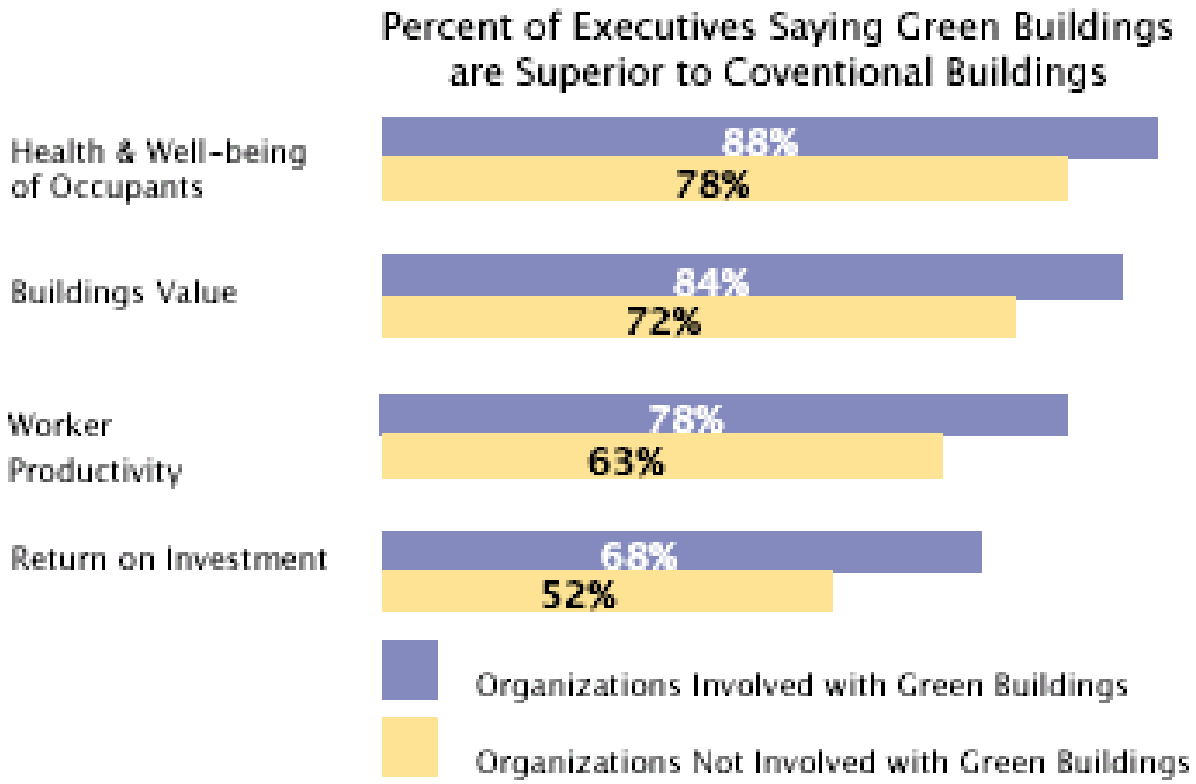
Partners Include:

Enterprise Community Partners
Fannie Mae
JPMorgan Chase
Citibank
AIA

See: www.greencommunitiesonline.org/about-partners.asp

Impact of Experience on Green Building

Figure G: Executives' Views of Green Building Benefits



Source:Turner Construction 2005 Survey of Green Buildings

From: "2005 Survey of Green Building," Turner construction/ *Greening America's Schools*, Capital E, 2006. Available at: http://www.turnerconstruction.com/greensurvey05.pdf

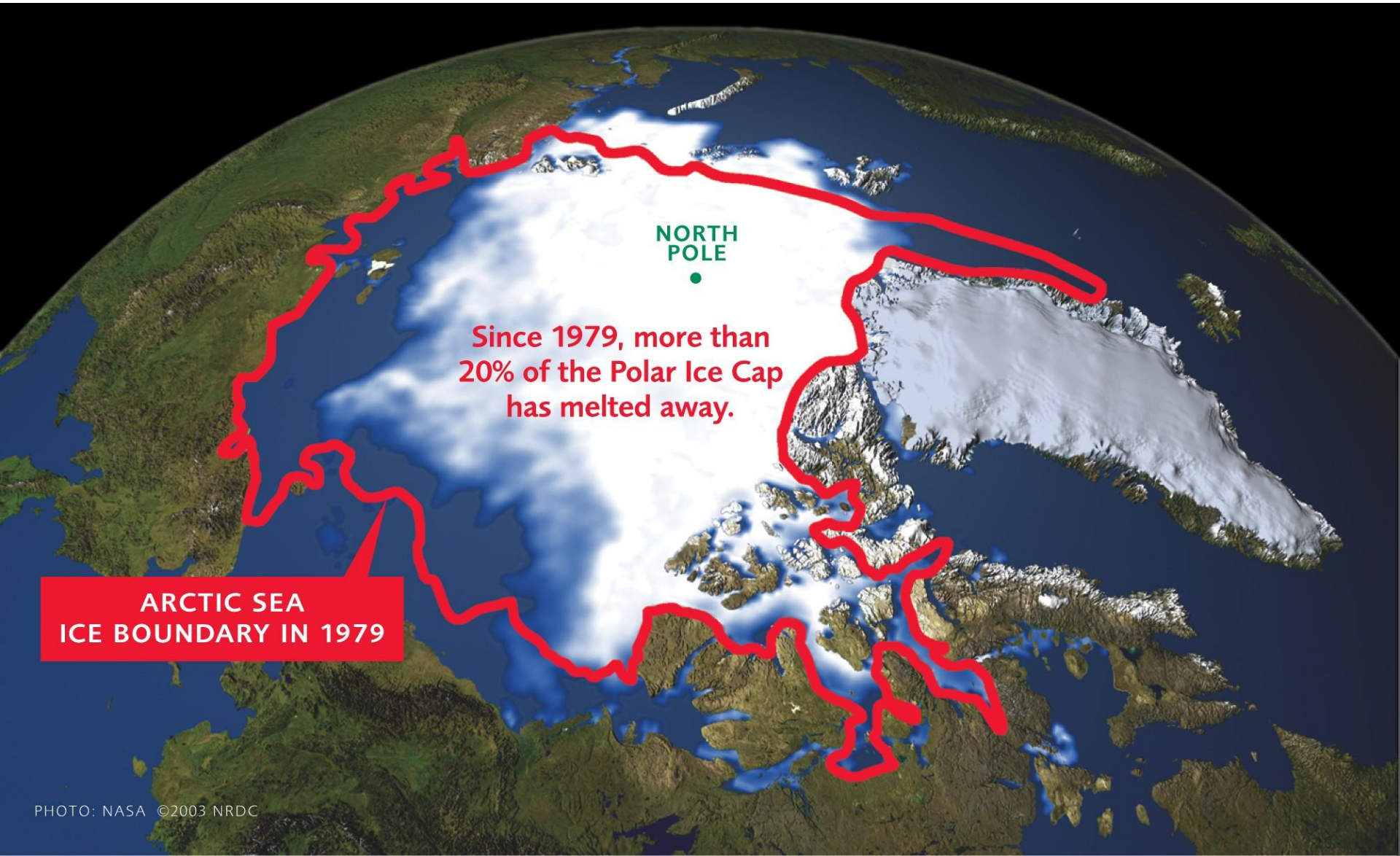
Direct savings for an average green school

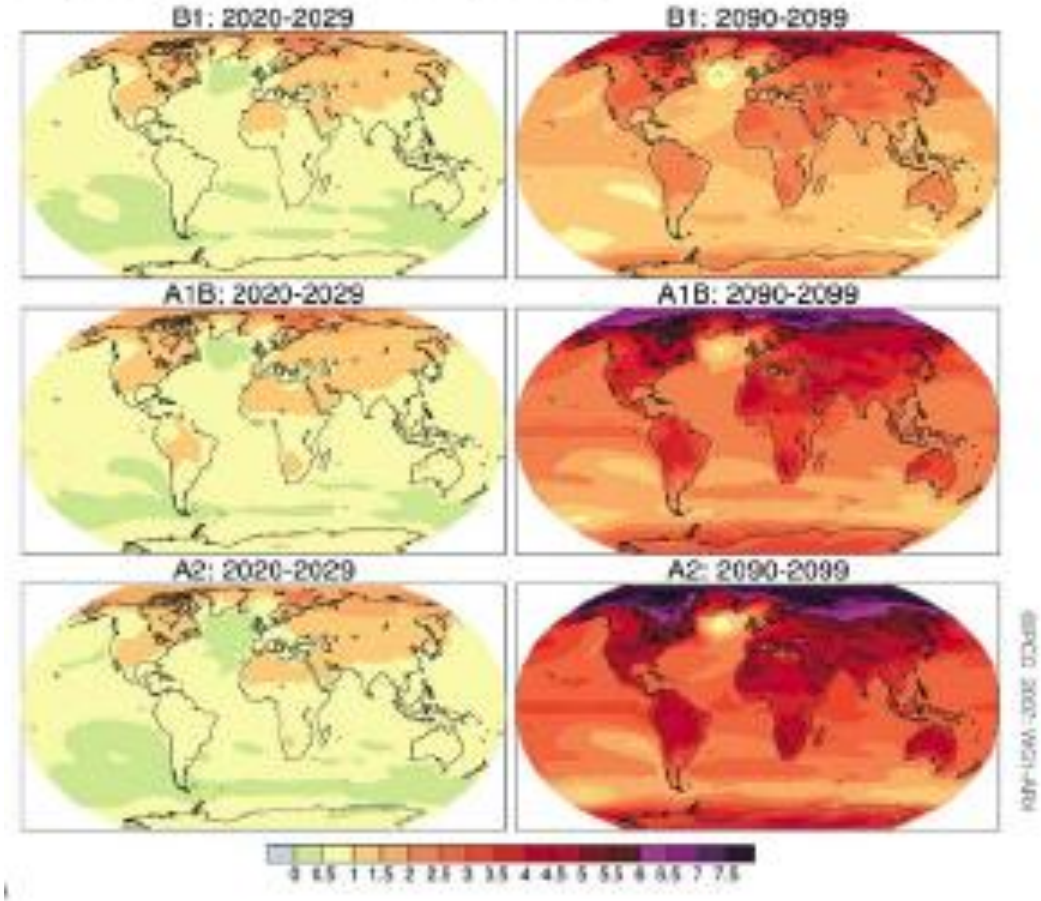
First year direct energy savings per school	$47,880
First year total direct savings per school	$95,760

Potential National Savings from Greening all School Construction

Jobs created annually from energy efficiency	2000
Total national energy savings over 10 years	$20 billion

Global Warming is Now





"FIGURE SPM-6. Projected surface temperature changes for the early and late 21st century relative to the period 1980–1999. The central and right panels show the Atmosphere-Ocean General Circulation multi-Model average projections for the B1 (top), A1B (middle) and A2 (bottom) SRES scenarios averaged over decades 2020–2029 (center) and 2090–2099 (right)."

"Warming of the climate system is *unequivocal*, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice, and rising global average sea level."

-Intergovernmental Panel on Climate Change, February 2007 report

Pew Center on Global Climate Change, Business Environmental Leadership Council

42 members representing $2.4 trillion

in market capitalization:

“1. We accept the views of most scientists that enough is known about the science and environmental impacts of climate change for us to take actions to address its consequences.

2. Businesses can and should take concrete steps now in the U.S. and abroad to assess opportunities for emission reductions, establish and meet emission reduction objectives, and invest in new, more efficient products, practices and technologies.”

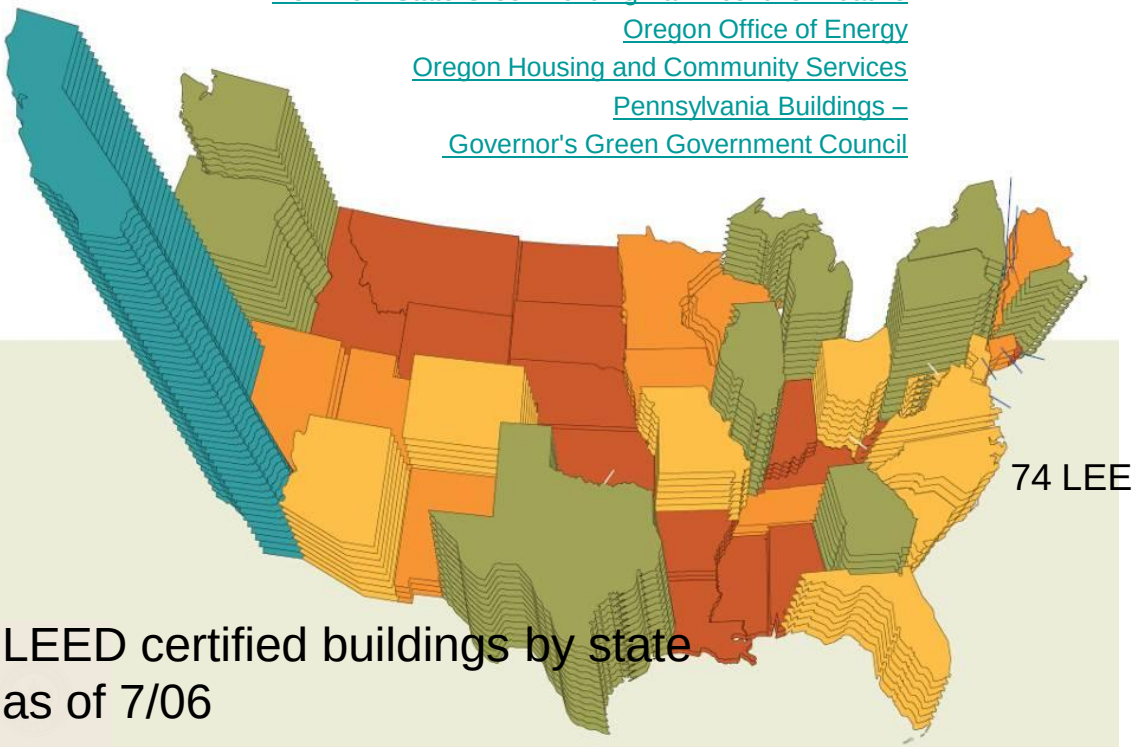
40+ state and local green building initiatives and ordinances

State/Provincial Government

British Columbia Buildings Corporation-Green Buildings BC
California Integrated Waste Management Board - Green Building Program
California High Performance Schools (CHPS)
Florida Sustainable Communities and e-design
Maryland Green Building Program
Minnesota Sustainable Design Guide
New Jersey Clean Energy Program - design support incentive
New York State Energy Research & Development Authority (NYSERDA)
New York State Green Building Tax Incentive Initiative
Oregon Office of Energy
Oregon Housing and Community Services
Pennsylvania Buildings – Governor's Green Government Council

Local Government

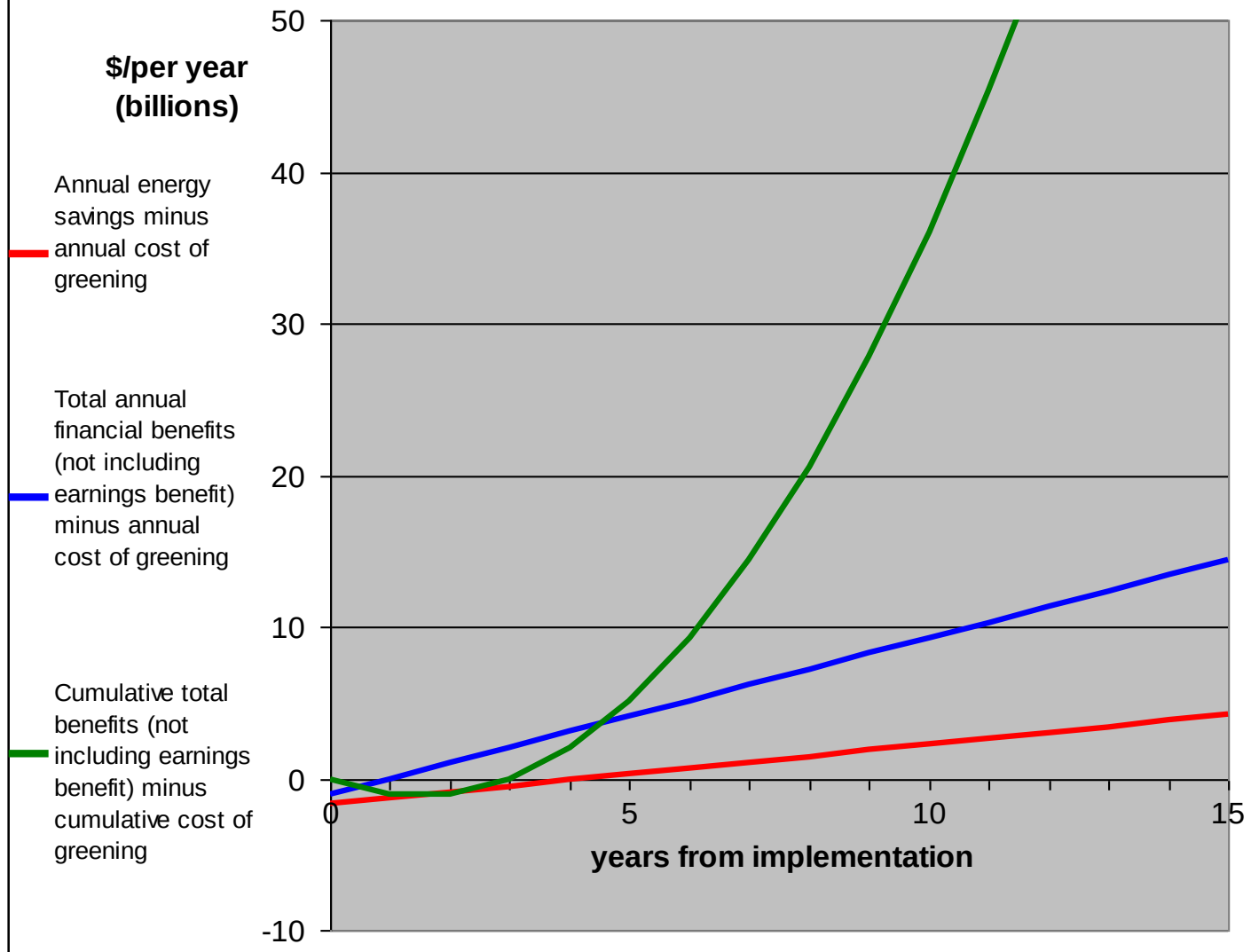
Alameda County, CA, Waste Authority - Green Building programs
Arlington County, VA - Green Building Incentive
Austin, TX, Green Building Program
Battery Park City Authority, NYC - High-Rise Residential Green Guidelines
Boulder, Colorado - Green Points Program
Cambridge Sustainable City
Coconino County, Arizona - Sustainable Economic Development Initiative
Hennepin County, MN - Sustainable Design Guide and Rating System
ICMA - Green Building Goes Local (article)
Issaquah, WA - Sustainable Building
King County, WA - Green Building Program
Kitsap County, WA - Build a Better Kitsap
Los Angeles, CA - Green Building Guidelines
Miami-Dade County, FL - Green Coalition
New York City High Performance Building Guidelines
Oakland, CA - Green Building Resource Center
Philadelphia, PA – Schools: Save Energy Campaign
Portland, OR - Green Rated
Portland, OR - Office of Sustainable Development
San Francisco, CA - Green Building Program
San Jose, CA - Green Building Program
Santa Barbara, CA - Innovative Building Design initiative
Santa Monica Green Building Guidelines & Ordinances
Scottsdale, AZ, Green Building Program
Seattle City Light - Built Smart program
Seattle Sustainable Building
Triangle J Council of Governments – High Performance Building Guidelines
Washington, DC - Metropolitan DC Council of Governments



LEED certified buildings by state as of 7/06

74 LEED certified buildings in North Carolina

Estimated net financial impact* of greening all US school construction



*Does not include many additional benefits not quantified in report.

New Study
Greening America's Buildings and Communities: Costs and Benefits

- Expanded data set: 100-200 buildings
- All building types
- Community projects: mixed use-high density, traditional neighborhood developments, transit-oriented developments
- Broad set of benefits including physical activity/health benefit, public infrastructure, etc.
- Sponsors to include USGBC, American Public Health Association and others…

Send us your data!

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